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CAPITAL

Curriculum and Pedagogy in Technology Assisted Learning

**Harnessing Technology research project Lot 2
undertaken jointly by the University of Nottingham
and Sero Consulting Ltd working in association with Becta**

Year 3 final report: Shaping Contexts to realise the potential of technologies to support learning

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1. Introduction and Research Methods

1.1 Report aim

This is the final report on the Capital project (Curriculum and Pedagogy in Technology Assisted Learning), undertaken by the University of Nottingham and Sero Consulting Ltd in association with Becta from April 2008 until August 2010.

This project was initiated in support of the Government strategy for E-learning set out in the Harnessing Technology Strategy (DfES, 2005; Becta, 2008) and ended when this was discontinued after the change of Government in 2010.

This report presents findings that are relevant to a leadership and policy audience drawing upon a broad selection of Capital work. In the first year of this work, we carried out a research-based investigation into the conditions of innovation and implementation of technology-based innovation in Education. This work helped identify claims about the widespread adoption of technologies to support learning and also blockages to the process of adoption. In the second year, we investigated these claims, examining in closer detail barriers to adoption and implementation that help explain variation in practice across the system.

The aim of this report is to synthesise the Capital work over the last two years, identifying the most promising strands for development in educational technology as well as the circumstances that need to be created to take up these opportunities. Importantly, this report structures the work in order to communicate findings as clearly as possible for a wide audience of researchers, policy makers and education leaders.

1.2 Structure of Report

This report examines ways in which technology presents opportunities to mediate learning interactions and then identifies key contextual themes that shape the potential of these opportunities. Contexts vary and are dynamic, so it is intended here to provide a conceptual tool with which to reflect upon any context of learning and consider how it might be shaped to take advantage of the learning opportunities afforded by technologies. The Department of Education has recently indicated that it believes technology is now well embedded in schools and does not require further “hypothecated capital investment” (DfES, 2010). In that context

it is hoped that this report provides a tool with which to realise the potential of available technologies.

The report is structured into four main sections.

Section 1. Capital Background and methodology; sets the scene for the report, providing some of the background to the lines of discussion and locating the report in relation to other work.

Section 2. Supporting learning through technology; argues that it is helpful to reflect upon the nature and forms of learning interactions in order to consider how technology can productively mediate these interactions. So, this section describes a framework, generated during the Capital work, to help locate technologies in relation to learning (including the identification of gaps and opportunities), whilst acknowledging that learning is something that is always orchestrated in a particular context and thus, the context will be an important determinant of how effective the technology proves.

Four examples are then presented, varying in the extent of current adoption, of ways in which certain technologies can enhance particular learning interactions. These examples emphasise the opportunities presented by these technologies whilst drawing attention to particular barriers to their adoption becoming more widespread.

Section 3. Opportunities and challenges of adopting and implementing technologies; reflects more generally on the barriers to innovation that will shape the successful adoption of technology to support learning interactions. The report presents a framework to structure these contextual challenges, compares the framework to external work and uses it to discuss different contextual themes under the following headings: Environment, Learning Content, Agents and Tools.

Section 4. Summary Conclusions and Recommendations; the final section of the report, reiterates the key aims of providing a conceptual tool, informed by Capital research, to help reflect and act upon individual contexts with the aim of realising opportunities to adopting technologies to support learning. The work is briefly discussed in relation to the Harnessing Strategy Outcomes that orientated Capital's initial direction before finally presenting some key recommendations, structured around the four heading identified in the previous section.

1.3 Background and methodology

1.3.1 Background

Technology is transforming activities across all sectors of society. New technologies emerge at great pace, often unpredictably. They change the quality and efficiency of established practice. The belief, therefore, that new and emerging technologies offer great potential to support learning is perhaps not surprising. Indeed, over the course of this research some of the new trends identified, such as mobile learning or e-assessment, have already become familiar, being firmly adopted in some settings, illustrating the pace of change. Yet the adoption of new technologies is not always straightforward and some which were widely identified in our Year 1 work on Trends (Chowcat et al, 2008, Phillips et al, 2009) as 'significant' have not progressed as expected given their pervasiveness outside of educational settings. Amongst this range of technologies we later focus on are Web 2.0 Social Tools and Gaming technologies.

We drew upon a wide spectrum of reports in formulating our research, with many such as the Horizon Reports (Johnson, Levine & Smith, 2009) heralding the great potential shown by novel technologies. These visions, however, are often removed from the complexities of everyday teaching practice. Indeed, there are large differences in levels of penetration and pedagogies between, and within, institutions.

The emerging policy environment suggests that there may be an increase in diversity of educational contexts if power is devolved, so technologies offer an important toolkit with which to increase choice and respond to needs. However, there is potential danger that increased choice is synonymous with fragmentation and without effective mechanisms for sharing successes as well as difficulties there is the risk of duplication of effort. This work intends to address this need by describing the potential value of technology whilst examining the significant challenges in adopting and implementing these technologies within different institutions.

1.3.2 Methodology

This Harnessing Technology Research Programme was initially designed by the research partners: Learning Sciences Research Institute at the University of Nottingham and Sero, in cooperation with Becta, as a three year undertaking to discern and analyse emerging

themes within Technology Enhanced Learning (TEL) rather than to present a comprehensive picture of the TEL landscape. A key strategy was to identify claims surrounding the benefits of technology in Education and then examine disjunctions between the promise and the reality of these claims, thereby gaining a greater understanding of the factors which support or enhance adoption of technologies into learning.

Due to the early closure of the project, work was carried out for just over two years. Within this time, key reports were made available through Becta's online documents repository¹. This final report draws greatly upon these earlier documents as well as other work. These are now accessible through the University of Nottingham². The key information sources for this work are summarised below.

Year One

At the core of the first year's work was the aim to pinpoint areas where technology is enhancing learning or to suggest scenarios where it might in the future enhance learning. The work further aimed to identify the barriers which were (or were likely to be) an impediment to innovation breaking out from being isolated examples by enterprising practitioners towards enjoying systematic and systemic adoption. The sources of information included:

- a series of desk research activities including national and international Horizon Scans and Trends Analysis;
- a series of Action Research³ projects (these respectively covered Primary, Secondary, Further Education, Higher Education and Adult & Community Learning) which ran throughout the year;
- a series of sandpit events at which practitioners, researchers and industry came together to jointly discuss a single topic, catalysed by a number of 'exhibitor stands' which exemplified a strand of that topic and around which delegates could circulate;
- an Expert Reference Group brought together for a two-day workshop which employed an adapted version of the Delphi forecasting technique to gather and distil

¹ <http://publications.becta.org.uk/>

² These reports are available upon request, or can be downloaded from www.lsri.nottingham.ac.uk/capital

³ Defined as research undertaken by practitioners for their benefit, as part of a process of institutional or social change, comprising a cycle of planning, action and fact-finding about the result of the action.

expert views (this activity was supplemented by a series of individual in-depth interviews with selected experts);

- the ALT Symposium at which 35 Learning Technologists (drawn from ALT's Research Committee and the LSRI/Sero Research Team) came together to discuss their experiences of, and forecasts for, TEL in the context of Higher and Further Education using a systematic process of Hindsight, Insight and Foresight;
- a series of Case Studies which illustrated instances of technology enhancing learning but which also sought to identify the environmental conditions which may facilitate, inhibit or impede sustainability and/or widespread adoption.

Year Two

Our Year Two work was initiated by collecting from media and research literature identifiable claims concerning the benefits of technology. These were then distilled to ten key claims each of which fell into one of the following three broad themes:

- Learning Spaces and Tools
- Curriculum and Assessment
- Education workforce training and development on TEL.

The ten claims⁴ are shown in Appendix A. Our approach was to probe these in order to evaluate the gap between their face assertions and the reality of educational practice whilst unpicking the various contextual mechanisms that might be sharing that gap. In parallel with these probes, we also investigated cross-cutting integrating themes including: New Modes of learning with technology (Sharples et al, 2009; Jones et al, 2009); technology in Other Sectors (Balmer et al, 2009), International Perspectives (Bacsich et al, 2010), and Innovation (Jeans, 2010).

Information gathering sources included:

- desktop analysis of the research literature and 'grey' literature (e.g. media reports) using a collaborative referencing tool to coordinate efforts across Capital researchers.

⁴ We defined a Claim as "An assertion concerning relationships that hold between an ICT innovation and some aspiration for effective educational practice"

Research was extended to survey evidence for the claims in countries outside of the UK and also to carry out further horizon scanning and trend analyses;

- interviews with individuals who had instigated or experienced instances of change management in the adoption of innovative technology in sectors other than education;
- holding two practitioner forums to investigate the conditions and issues surrounding innovation and its embedding - participants at each forum were drawn from all Education sectors and took part in plenary and small group discussions with subsequent opportunities to feedback over the following weeks;
- examination of over 300 industry websites, reviews of blogs sites, publicity and appeals via email lists in order to interrogate the evidence for take-up of new modes of learning⁵. By asking why such credible new modes of learning were not in widespread adoption, it was possible to identify further barriers. These new modes were:
 - Live reflection
 - Rich feedback
 - Learning community trails
 - Gaming to learn;
- consultation exercises with expert reference groups in order to test the implications of emerging project findings among a wider grouping of representatives from across all education sectors and industry.

2. Technologies within learning interactions

This section considers learning as a diverse set of ‘interactions’ and highlights how technology can be adopted to shape or configure the form of those interactions and presents examples to illustrate the potential benefits as well as challenges of adoption.

2.1 Generative Framework (GF)

Learning is complex, involving a multitude of interlaced factors including the learner, teachers, tools and subject to be learnt. Differences in these factors will moderate the outcome of particular learning interactions and the sequences of such interactions. One

⁵ Each new mode of technology-enhanced learning described is a concept-proved and desirable (pedagogically sound) initiative that nevertheless remains at the ‘new but neglected’ level.

clear trend identified in this research is the changing nature of what is considered a learning context, where learning opportunities are not confined to specific teacher-learner interactions in formal contexts. Given this change in interpretation, it was considered important to develop a language to think about different types of learning interaction and how changes in various contextual factors, notably new technologies, mediated these interactions.

Categorising and labelling interactions is fraught with difficulties given their dynamic nature. Some learning interactions are social. Their exchange might be interpersonal or community based. Other interactions are with the material world or with representations made available in that world. However, tools always mediate such interactions. And digital technologies can function as such tools in learning. In the second year, a report was produced (Sharpley et al., 2009b) that articulated a generative framework with 16 different types of learning interactions that developed from part of the final Year 1 report (Sharpley et al., 2009a).

The framework can describe established practices and it can also be employed to anticipate novel circumstances for supporting learning. It is being revisited and developed in the light of further research into the processes of learning. The most recent list of identified learning acts is presented in Appendix B. Rather than offering a definitive taxonomy, this framework seeks to be generative: that is to inspire thoughts about the nature of learning and the mediating impact of different forms of tools that can support the interactions of learning. In this framework, digital technology is conceived as the mediating tool. In the following section, a summary of key findings are presented through four chosen examples of how technology can mediate certain types of learning interactions.

From the 16 learning acts presented in the Generative Framework in Appendix B, we examine four: *Ludic*, *Assessing*, *Collaborative* and *Cross Contextual*. Table 1 provides a short description of the forms of interaction and examples of technology that can mediate these interactions. Two of these, e-assessment tools and mobile technologies, are becoming more embedded in current practice and, reflecting this, have received more substantial examination through our work during Year 2. Gaming technology is presented, as this was discussed in Year 2 as a possible example of a new mode of learning. With respect to collaborative learning acts, we discuss a variety of web tools that we have considered during the research, all of which foster collaboration.

Table 1: Four examples of Learning acts and mediating technologies

Learning Act ⁶	Form of Interaction	Example Technologies
Assessing	Interactions that revolve around feedback to the knowledge building learner	E-assessment tools
Collaborative	Opportunities for two or more individuals to purposefully create shared knowledge	Online Social Tools
Ludic	Opportunities for playful, enjoyable and relatively undirected engagement with domain-relevant material	Gaming technology
Cross-Contextual	Opportunities for learner to integrate meaning across different contexts of representation or activity	Mobile technology

By focusing on specific learning interactions, these examples do not describe the wider learning interactions that a particular form of technology may offer. Mobile devices, for example, can be adopted to support other acts such as collaboration or reflection. We also do not attempt to provide an account of what technology can best support each learning act. Rather, our intention is to illustrate the diversity of learning interactions and the opportunities and choices associated with positioning various technologies into those interactions

2.2 E-assessment to support *assessing* learning interactions

2.2.1 Introduction

Assessing is described in the framework in terms of an interpersonal dialogue with the learner, in order to provide timely and high quality feedback on some activity. However, to understand the uptake of assessment tools that employ new technology, it is important to understand the context of current assessment practice. In particular, to appreciate the many situations where assessing the learner is used to evaluate both the teacher and institution as well as provide a summative record of the learner's ability and determine access to further

⁶ The term 'Learning act' was adopted in prior work to encourage thinking of "learning" not as some singular process but as cognitive change that is brought about by engaging in various forms of interaction with the world

learning or work opportunities. This difference in purpose for assessing corresponds to a commonly-held distinction between formative and summative assessment, or ‘assessment for learning’ and ‘assessment of learning’. According to Wiliam (2009), good formative assessment not only provides pupils with knowledge of their results but provides an explanation and possible activity to act on this information for the purpose of improvement. Criticisms of current assessment practice tend to highlight the over-emphasis on summative assessment to the detriment of assessment that can help inform and support teaching and learning (e.g., Epic, 2010; RMIT, 2009; House of Commons, 2008).

In our work, we used the term ‘E-assessment’ to refer to any use of digital technology to support an evaluation of a student’s progress in learning (any activity undertaken to gather and evaluate information about a student’s learning). By including tools to gather and store information (e.g., e-portfolios) this term is broader than the definition of e-assessment provided by JISC (2007): *“the end-to-end electronic assessment processes where ICT is used for the presentation of assessment and the recording of responses”*.

2.2.2 Learning Benefits

The introduction to the document “Whither Assessment” (QCA, 2003) describes a vision of ICT replacing most paper based testing and new technologies creating *“exciting opportunities, not currently possible, to assess skills and knowledge”*. The articulated vision then describes how the assessment process would become more efficient, reliable and provide more timely and information-rich feedback. This vision was endorsed by the QCA (Boston, 2004) who have spoken optimistically of assessment in which technology was presented as a catalyst for change.

Key themes that seem to emerge from the literature (e.g. PwC, 2008) regarding the benefits of technology enhanced assessment for learning reflect (a) the efficiency gains for awarding bodies, (b) the capacity to assess a broader range of skills, and (c) the potential to integrate assessment into learning. In this last aspect, the technology is seen as supporting the teacher’s role as a mentor as well as enabling the benefits of self and peer monitoring.

There are clear moves by awarding bodies to migrate high stakes (e.g. A levels) assessment from paper to electronic media. In support of this, the examination regulators of England, Wales and Northern Ireland developed a guide for effective practice using e-assessment (e-futures, 2007). (The Scottish Qualifications Authority (SQA) has developed a similar guide).

The guide provides many examples of successful use of e-testing and e-portfolios in assessment. In 2005, 26% of awarding bodies used e-assessment to deliver, on average, 29% of their assessment program (Thomson, 2005). In our interviews with leaders of awarding bodies, it was emphasised that efficiency gains are ultimately beneficial for the learner. E-assessment offers greater flexibility (different locations, different times), faster feedback, and reduction in administration costs (OCR, 2009; AQA, 2008). Also, by supporting the workload for human markers, assessment can be made more reliable. The e-learning company Epic argues that tests can be more consistent, relevant, reduce cheating and save marking time (Epic, 2010).

However, these benefits described relate mostly to the efficiency gains of summative assessment. In contrast, the potential to assess a range of skills that is broader (e.g. using video to help assess drama), and more fully to integrate assessment into learning activities resonates with claims around the transformational potential of e-assessment (e.g. Cisco, Intel, & Microsoft, n.d.; RMIT, 2009; Ripley, 2003). In these discussions, technology is said to change the nature of assessment practice, broadening the range of what is tested, providing evidence of cognitive and skill based achievements in ways that are durable and transferable, and encourage deeper learning (e.g. JISC, 2007). One key tool that is gaining in appeal is the e-portfolio, which provides the means to store and organise a rich multimedia range of assessment evidence, integrating assessment material from sources such as digital cameras and mobile devices (e.g. Molenet, 2008). The e-scape project reported in our case study (Patterson, 2009a) also exemplifies the potential to integrate a richer range of materials for assessment.

The potential for technology to transform the nature of assessment feedback was expressed in Capital's work on new modes for learning (Sharples et al, 2009a; 2009b). 'Rich feedback' described the way that technology could make shared and visible the reactions of a teacher/reader to the learners' responses to some assignment and do so in as vivid a manner as possible. To achieve this, the assessor's reaction must be tightly integrated with the substance of the assignment and make use of hi-fidelity communication formats to convey the full tone and target of that reaction. One example is the MAPS project (which won a BETT show award in 2007 for innovation in assessment) which incorporates a tool termed 'redpen'⁷). This allows the assessor to make rich media insertions (including voice) to

⁷ <http://www.redpentool.com/>

the submitted material. However, although there are case studies of success⁸ uptake and effectiveness of the tool is as yet unclear.

2.2.3 Challenges and opportunities

Although e-assessment tools have the potential to assess a wide range of skills and possibly deeper learning, some barriers exist to their universal adoption for summative assessments. According to one interviewee in our research (see Manches, 2010a), a fundamental challenge in the evolution of technology-enhanced summative assessment, particularly high stakes, is the need for comparability across learners, subjects, and yearly cohorts. Also, one main advantage of transferring high stakes assessment to e-assessment, greater flexibility, may also be compromised as assessment must take place at a set time in a set place in order to prevent possible cheating, a key issue in e-assessment (Ofqual, 2009). Although cheating in exams may be addressed by having randomised question banks and more recently webcam tracking, this nevertheless places considerable burdens on awarding bodies and testing companies to generate these. If assessments need to happen at the same time for all candidates, then this requires institutions to have the capacity to allow multiple users to have technology access simultaneously. According to an assessment company manager interviewed (see Manches, 2010a), one problem is that many schools are built around computer suites, where there are not enough computers to provide one for each student. A further potential problem is that technology infrastructure may not be robust enough to guarantee availability throughout the test period. Indeed, an interviewee (see Manches, 2010a), described how this, coupled with the difficulties in administration, could have been a contributory factor in why the introduction of the KS3 ICT exams was not successful. Infrastructure constraints are important as technologies for assessment require a wider range and a larger amount of information to be stored and shared.

‘Assessing’, as a learning interaction, emphasises the importance of quality feedback to learners and yet many current innovations focus on the more summative aspects of assessing. An unfortunate reality is that the need to produce quantified assessment data is a pervasive part of teaching. This was highlighted in the Capital research by the quantity of resources shared through teacher forums (e.g. *TESConnect*) that focused on organising assessment data, such as spreadsheets for mapping children’s assessment levels. Importantly, one of the key benefits purported by current assessment software is the

⁸ <http://www.tagdevelopments.com/content/case-studies>

capacity to produce performance scores. These scores will help provide the teacher with assessment data and the learners with quick knowledge of their results but they are unlikely to provide explanations of any student misunderstandings – a key dimension in making assessment formative (Wiliam, 2009). An important question therefore is how easily teachers can assimilate technology-based tools into their practice. Although e-assessments may support dialogue by providing teachers with a better understanding of where to direct their remedial efforts (and learners of their own progress), teachers may lack the skills or confidence required to adapt e-assessment packages to their context. The more comprehensive packages may even have a negative effect on dialogue by reducing the likelihood of improved face to face feedback. As such, this would represent a risky trade-off between efficiency and quality of assessment.

2.2.4 Summary

Technology has shown great potential to support assessing as a learning interaction. There are exciting forms of e-assessment emerging, for example, assessment integrated into simulations or criterion referenced assessment, where students can re-take tests (and examine the results), until they reach a success criterion.

The most significant moves toward e-assessment are being made by awarding companies where technology presents promising efficiencies. Some of these may benefit learners, such as the speed of results feedback, but they may be limited in support for the more complex dialogue between teacher and student where assessing is a means to identify and remediate more particular misunderstandings. Currently, up to four fifths of teachers report using technology for learner assessment only “a few times a month” or “rarely/never” (Harnessing Technology Schools survey (Rudd et al., 2009, p.23).

There are emerging tools designed to support teachers in assessment for learning, yet many of these demand a degree of technical confidence and a suitable operating infrastructure. They may also be disempowering by having a rigid design that is difficult for teachers to adapt to their own contexts. There are also concerns over the *depth* of knowledge that can be assessed through technology-based approaches. There are some progressive resources that have been designed with higher order thinking in mind, such as the Bowland Maths Materials described in one of our Case Studies (Manches, 2010b). However, such materials call for substantial investment to produce and require authors to be imaginative as well as

possessing in-depth subject knowledge and an appreciation of how the subject can be assessed using sophisticated tasks. This combination of skills is difficult to achieve.

It is argued, therefore, that more effective progress will emerge from the use of Open Educational Resources (OER) and tools such as Moodle⁹ or E-portfolios. E-portfolios provide a structure for teachers and learners to store and share rich sources of assessment evidence, although they do not as yet provide quantifiable data or feedback themselves. They are currently mainly used for more work-based assessments that require portfolios of evidence. Consequently, their potential for adoption is more determined by the wider culture of assessment practice. For example, calls for comparative assessment (Pollitt, 2004) illustrate how technology can support teachers in comparing rich forms of assessment and help learners to evaluate their own and peers' work. In this way, technology may truly shape practice and benefit the learning act of assessing as described by the Generative Framework.

2.3 Online Social tools to support *collaborative* learning interactions

2.3.1 Introduction

Online Social Tools are a pervasive form of technology. A key area of research in Capital has been how these tools can be adopted to support collaboration amongst learners. We define collaborative learning as *“an interaction in which two or more individuals deliberately strive to create shared knowledge”*. The push towards an often poorly defined notion of technology-supported 'personalised' learning has sometimes appeared at odds with this more social aim. However, at the outset of our research we noted that technologies can offer scaffolding through which personalisation and collaboration do not simply co-exist but they complement one another (Chowcat et al., 2008b).

The potential for technology to foster collaborative learning acts was explored by Capital in various approaches including the standard discussion forums on institutional Virtual Learning Environments (VLEs), subject specific blogs and wikis and co-created open educational resources (OERs). We also examined the many social networking tools that might be

⁹ <http://moodle.org/>

exploited for educational purposes and proprietary specialised platforms such as that employed as the foundation of the Eat-A-Metre project (Balmer, 2009a). In the HE sector there are well established examples of Ning sites or similar tools being created to enable students (and staff) to collaborate (Phillips, 2009a).

Partly in response to this changing landscape we have seen a growing interest in the design of physical learning spaces which support and facilitate collaborative learning - often underpinned with new technologies. These were apparent in both our Case Study of the Building Schools for the Future new-build Yewlands Technology College (Phillips, 2010c) and that of the Learning Hub at Nottingham University's Hallward Library (Mitchell, 2010).

We also noted a growing trend towards the *"...technology enabled 'social marketplace' for learning in the workplace"* (Phillips, 2009a) whereby employers were augmenting or replacing traditional Continuing Professional Development (CPD) strategies with social networking tools to facilitate collaboration amongst employees.

2.3.2 Learning Benefits

During August 2009, over forty Bristol schools (covering nurseries, primary, secondary and special schools, a pupil behavioural unit and a teenage pregnancy unit) took part in the Eat-A-Metre project. Each school created its own micro market-garden and used data loggers, digital cameras, digital microscopes, and computers to share the resultant data about the growth of the plants across a central web-based database and to create online diaries. Children were able to access both individual and cumulative data entered by participating schools and could collaborate with others and/or compare their data across the city. Not only did this engender a high degree of engagement with a curriculum area which has historically been problematic for the city (data-handling) but it was also found to strengthen home-school and school-community links. This was a large-scale, and yet relatively user-friendly, illustration of the advantages of technology enhanced collaborative learning (Balmer, 2009).

Elsewhere (Chowcat et al., p. 29), we reported how blogs and wikis allowed students to collaboratively create and share their own content. Students can also review each other's work and publish on the web to get feedback from other audiences. They can share comments on the work of others and, through developing such critiques, create new content of their own.

In the HE sector a JISC study identified benefits to learners from the use of social software tools in their learning. The report notes how *“...using social software tools assists students develop team-working skills and online collaboration and communication skills, which will help them to fit easily into work settings.”* (Minocha, 2009 p9).

The application of social tools to work-based learning was said to have had significant impact in terms of reducing costs, the speed with which technical content could be disseminated to dispersed learners and in its durability with the employees (Phillips, 2009a).

2.3.3 Challenges and opportunities

Whilst there has been significant conjecture concerning the educational potential of learners' own social ICT spaces, we have noted several reports of both a resistance on the part of learners to the use of their social ICT spaces for education, and a lack of understanding on how they might be used in this way (Minocha, 09). Collaboration requires input from learners and if a student does not receive (appropriate) feedback from their peers they may disengage from the activity (Minocha, 2009).

Even in the HE sector where there is possibly the greatest immediate potential for social tools (where a more discursive and enquiry based approach to learning may be adopted and there are fewer fears about e-safety and network security), Web 2.0 social tools have not widely permeated teaching and learning. There is modest take-up generally of Web 2.0 tools in schools and previous research illustrated a tendency for these to be confined to school intranets or their protected web areas. There is little evidence that children are engaging with these tools outside of school and in many cases the use of blogs and wikis has been an extension of well-rehearsed 'traditional' teacher led creative and collaborative writing activities (Crook, 2008).

A key theme determining the potential impact of online social tools is how easily these can be integrated into the curriculum. We reported that some secondary schools were moving towards a curriculum which emphasised enquiry-based and collaborative learning of the kind familiar to primary practitioners. At the same time there has been a keen interest in the development of the 21st century skills predicted to be required of learners - central to these has been technology enabled collaboration. In the course of our Claims activities we noted that *“there is a match between what are seen as 21st-century learning skills, 21st-century*

employability skills and those engendered by engagement with Web 2.0 – communication, participation, networking, sharing.” (Patterson, 2010b).

There was also some evidence that in these contexts learners are gaining experience in selecting ICT tools that are appropriate to the task in hand or that enrich the learning experience (Patterson, 2010b).

2.3.4 Summary

Schools should build upon the technical, media and collaboration experience and enthusiasm that children bring into class. The focus should be less on teaching *about* the technology and more on how to *learn* with new technology (Phillips, 2010c). This conversational and/or collaborative learning is particularly apparent in Higher Education. The New Media Consortium notes:

“The work of students is increasingly seen as collaborative by nature, and there is more cross campus collaboration between departments. While this trend is not as widespread as the others listed here, where schools have created a climate in which students, their peers, and their teachers are all working towards the same goals, where research is something open even to first year students, the results have shown tantalizing promise. Increasingly, both students and their professors see the challenges facing the world as multidisciplinary, and the need for collaboration great. Over the past few years, the emergence of a raft of new (and often free) tools has made collaboration easier than at any other point in history.” (Johnson et al., 2010 p4)

The apparent increasing devolution of power to individual schools and new federations which may bring schools together under a single sponsor whilst remaining geographically dispersed may mean an increased role for technology supported inter-institutional collaboration amongst learners.

2.4 Ludic interactions: Massive Multiplayer Online Gaming

2.4.1 Introduction

In the Generative Framework, Ludic interactions are described in terms of the motivational effects of domain-relevant materials that allow playful, relatively undirected engagement. As

such, work in the second year around the potential of Massively Multiplayer Online Gaming (MMOG) is highly relevant (Crook et al, 2009) where there is evidence that using this informal tool within the formal educational sphere could result in a high level of learner engagement (Kirriemuir & McFarlane, 2004).

MMOGs are the richest and most technically evolved genre of computer-based games. Large groups of distributed players, many of whom may not meet offline, engage in an ongoing networked venture in a virtual world. The appeal is clearly wide – according to one expert interviewed in our research (Patterson, 2010c), the use of games between age groups and genders is consistently on the rise. The games also present other possible learner benefits beyond their playful appeal, such as opportunities for construction, reflection, collaboration and networking. These games are also forms of simulation – we considered how such tools could provide a motivating platform to develop higher order thinking and the role-playing potential of simulations for assessment purposes was also considered (Patterson, 2010c).

Conventional versions of such games dwell on familiar recreational themes: warfare (e.g. World of Warcraft), science fiction scenarios (e.g. The Matrix Online) and role playing (e.g. Neverwinter Nights). The expectation associated with the ‘gaming to learn’ mode is that these approaches to the design of online experiences can be adopted and adapted to represent topics which are closer to the traditional curricula of formal education and skills.

The lack of any central data collection on the use of games in schools and colleges means that it is difficult to make firm statements about the current usage levels of games within education. The European Schoolnet survey reported that ‘the use of digital games in the classroom teaching process is not common practice in any country (Wastiau et al., 2009) but found evidence that the practice is growing. They gave examples, including the work of the Consolarium¹⁰ in Scotland, where electronic games are being tested on a larger scale. The use of MMOGs is currently a fringe practice within the UK education system, even in those schools where computer games have been embraced. Their marginal nature within education is reflected in gaming research and relevant conferences where specific examples of any established use of online gaming are rare.

¹⁰ <http://www.Itscotland.org.uk/usingglowandict/gamesbasedlearning/consolarium.asp>

2.4.2 Learning Benefits

The rise of gaming as a leisure activity highlights the potential of such games to motivate individual learners in designed activities. From a pedagogical point of view, MMOGs present possibilities for players to develop 'complex social skills from their experience' (Yee, 2003). These complex skills include leadership, collaboration, cooperation and the opportunity for players to share their learning within the game. When MMOGs are used as the basis of 'games-based teaching' (Pivec, 2009), there are opportunities for the games to act as springboards into curriculum-based learning. Pivec also reported that multi-player learning and better game-play were the two key features that students indicated would motivate them to play games for learning.

The potential for game simulations to provide a means to practise and reflect on 'real world' skills helps explain interest to support more vocational learning: for example in emergency medical response training (Chen et al, 2008). This is reflected in the use of simulations to provide environments to practise more computer orientated skills as seen in the KS3 ICT tests. What is perhaps less clear is how they can integrate more abstract learning content from different domains in a way that is meaningful. It is possible, however, that concerns over what is learnt through gaming reflects current curricula objectives. Our work on curricula to support 21st Century skills (Patterson, 2010b), suggested that skills such as problem solving or working with others may gain greater recognition, and these skills may be more representative of those practised in MMOGs (although evidence for learning benefits is yet to be clearly demonstrated).

2.4.3 Challenges and opportunities

A key barrier to the adoption of Multiplayer gaming in schools is concerns over e-safety. The online nature of MMOGs and the possibility that learners can potentially interact with anyone who also happens to be playing the game at the same time means that MMOGs present additional challenges in the educational setting. Even if the version can be closed (to those outside the educational setting) there may remain unease at the uncertainty about identity. For these reasons, there is little evidence of MMOGs being used in schools and colleges without some type of safety measure being introduced. From our research we find that the current default position for schools and local authorities in the United Kingdom is that MMOG games (e.g. World of Warcraft) which cannot be controlled and used safely will not be used at all (because the risks outweigh any perceived benefits for the learners (Robertson, 2009). This contradicts the findings of the European Schoolnet survey which reported that 'the

approach adopted is that of education (of the learners) in the use of games rather than protection or prohibition' (Wastiau et al., 2009, p.89).

In contrast to educational contexts, multiplayer games are common in informal home settings which may present opportunities to build on learners' skills and interests developed through these games. However, the fact that learners can access MMOGs (and other types of computer games) at home raises concerns over the compelling nature of immersive gameplay. Schools and local authorities have reservations about introducing games within the classroom if they may lead to levels of game playing which could be considered to be unhealthy. There are also concerns about the implicit and explicit consumerism which is built into most MMOGs (examples include Moshi Monsters and Club Penguin). These concerns will largely reflect the interpretations of institutions and teachers, where those less familiar may be wearier (see Patterson, 2010c). Perceptions of gaming may therefore play a key role in determining the adoption of this form of technology, where more negative attitudes to gaming for learning will represent a much larger perceived risk in adopting them.

Many of the perceived risks of adopting gaming technology for learning (e.g. exposure to unsavoury content, inappropriate behaviour, over-engagement) can be managed by institutions if the learning benefits are deemed worthwhile. It is also possible to develop specially tailored games, rather than adopting commercial versions, for example, Shaffer's (2006a) work on epistemic games which are designed to help players learn to think like professionals in fields such as architecture. However, developing large simulations implies significant investment costs. Indeed, current examples tend to be grand commercial products. Therefore, the additional required expense to design these games for learning may be questioned, especially if education is not a profitable sector for the games industry. This also means that educators are limited in their ability to design their own games and must adapt existing tools. This can be done successfully; a well-publicised example being Tim Ryland's use of the game *Myst* (Rylands, 2007) to motivate creative writing amongst teenage boys. Yet, here it is the skills and confidence of the teacher to present and adapt the technology rather than the more independent learning described by this learning act in the Generative Framework. The role of the teacher was also a key theme to surface in our work looking at visual tools such as games to support higher order thinking (Patterson, 2010c). Tools varied in how much teachers could adapt the game to the particular context and needs of learners, and hence in teachers' ownership of the tool.

Another key barrier to the adoption of online gaming to support learning is the high profile negative media coverage of these aspects of children's gaming experience and concerns about whether the claimed benefits of game-based learning are pedagogically sound (Thomas, 2009; Futurelab, 2009). Indeed, there is some current research focused upon how learning needs to be intrinsic rather than extrinsically motivated by the game design (integral to the game-play rather than simply a reward (e.g. Habgood, 2007).

Even if games are seen positively, it is important to consider the initial technological hurdles which need to be overcome. Computer games often require the latest software (e.g. Flash and Java) and high specification hardware; these can be difficult to implement and to justify any additional expenditure within the constraints of a school or college's IT infrastructure.

2.4.4 Summary

There have been a range of projects successfully demonstrating how games can be adapted into a learning context; from large successful games (e.g. Sim City for teaching strategic thinking (BBC, 2002)), to simpler more curriculum focused activities that allow learners to compete within and between schools (e.g. Mathletics¹¹) Yet, compared to other forms of technology to support learning acts discussed in this report, Gaming, particular Massive Multiplayer Online Gaming to support Ludic, or playful, learning has yet to be significantly embedded in everyday practice. As such, it provides a good window onto the barriers for new digital tools being adopted or implemented in classrooms. Although they may be motivating for learners, it is not clear how easily an activity that is familiar and growing in popularity outside of schools can benefit learning *within* schools. Part of this difficulty may reflect attitudes to what constitutes good learning, and changes in perceptions to education may pave the way to greater acceptance. Our research highlighted the fact that it is easier to integrate games-based teaching into primary schools where the emphasis is already on learning being 'fun' or 'play-driven' and where the timetable is flexible enough to build multi-curricula classroom activities around the game playing sessions (Robertson, 2009).

The technical and e-safety challenges presented by MMOGs are not insurmountable but will probably involve the retention/introduction of 'boundaries' to ensure that learners are playing within a safe environment. For example, the use of Teen Second Life within Middlesborough CLC who ran CRB checks on all the adults who needed access (See Crook et al, 2009)

¹¹ <http://www.mathletics.co.uk/>

However, there is a question about how much of the MMOG experience is lost when this approach is taken and whether this significantly impacts on the skills that learners can build.

Games have a long history in learning and the use of simulations is also not novel. Therefore, it is possible to trace some key questions around their potential for supporting learning, such as how well learners can transfer any skills learnt beyond the simulation (e.g. Pea, 1983). Games and simulations have developed in recent years so they are increasingly more complex and networked, and this poses novel challenges for how easily they can be adopted in educational contexts. Whilst they may be motivating for learners, they place greater demands on institutional infrastructure (e.g. internet speeds) and importantly, challenges to minimize perceived risks. The greater complexity of games also requires teachers to familiarise themselves with the technology and feel confident in adapting the games to their own context.

2.5 Mobile technologies (to support Cross-contextual learning acts)

2.5.1 Introduction

Throughout the course of our research programme we have reported the growing trend towards new and emerging technologies supporting learner mobility. The increasing functionality, affordability, reliability and usability of the tools – the devices and applications, and the platforms across which the first two may be manipulated by the learner – is being exploited by educators (and learners) keen to extend learning beyond the classroom and the timetable. Teachers and learners are developing a greater understanding of the variety of tools available and their relevance to specific teaching and learning contexts. Mobile learning is not confined to learning with mobile phones. Our case study of Portland College (Phillips 2010e), where learners (with neurological injuries and/or conditions) have ‘road-tested’ PDAs, standard and new generation mobile phones, specialist pagers and even digital keyrings in order to develop a more sophisticated understanding of the issues, goes some way to illustrating the complexity.

Mobiles can generate information on position, and the use of such ‘geolocation tools’ is now apparent across all sectors of education. These tools exploit GPS technology to allow the user to denote the precise location of an object and/or to tag the location of digital photographs, videos and audio recordings at the point of capture. Allied with a growing

catalogue of inexpensive applications, there is considerable potential for these to become ever more pervasive in the foreseeable future.

However, as we note below, the near ubiquity of these mobile technologies amongst young people is not yet reflected in their educational experiences, particularly in the compulsory schools sector.

2.5.2 Learning Benefits

These tools allow the learner and teacher to integrate and manage activities over multiple contexts. Continuity can be created between the formal and informal contexts – across school, home, workplace, museum or field trip, and across time from the timetabled to the ‘just in time’. This may involve a variety of fixed and portable devices.

Extending learning across time and location has the benefit of opening up potentially valuable new sites for learning. In our Year Two Final Report we noted:

“We have found good evidence that technologies can enhance learning on visits and field trips, by connecting teacher-led framing of an enquiry in the classroom, to an investigation in a museum or outdoor location where personal technologies are used to collect evidence or create a personal viewpoint, then back to the classroom for sharing and presentation of results. This is one aspect of a more general theme of lowering boundaries between places of study, types of learner, abilities, and mode of learning.” (Sharples et al., 2010)

Throughout our research we observed the key benefits as:

- the immediacy and responsiveness of devices and applications enhances exploratory learning by enabling the gathering and reporting of rich data (images, video, audio etc);
- students were drawn into, and engaged by, learning away from the classroom – rather than the novelty of the devices;
- the new generation of devices such as smartphones, which children are already using for their own learning away from the classroom, can be powerful tools for enquiry and collaboration;
- supporting enquiry-based learning and active discovery through the construction of a narrative which then enhances data handling and analysis activities on return to the classroom;

- helping pupils develop research and reflective skills;
- offering the ability to transfer data easily across contexts;
- improving communication between staff and students.

In our Case Study of Yewlands Technology College (Phillips, 2010c) teaching staff and members of the Senior Leadership Team (SLT) indicated that embedding learning with mobile devices (in this case largely, but not solely, on-campus) was helping learners to exploit the flexible spaces in the new-build school and was driving enquiry based learning at the school. Feedback from staff and students confirmed the power of some personal technologies to motivate students from across ability and behavioural ranges – from the low ability to ‘gifted and talented’ and from recalcitrant to engaged. Student familiarity with the devices reduced the need for time to be spent training and staff also reported that when problems occurred students were keen to help.

The development of Personal Learning Environments (PLEs) represents one way to merge personal and institutional learning across contexts. The availability of new browser based tools, allied with cloud computing, offer new possibilities for the development of PLEs. There is the potential to achieve efficiencies whilst maintaining high-quality learner and teacher experiences although this is an area requiring further research. However, it is clear that, whilst there remain competing definitions of the PLE, there is now general agreement that it should not be viewed as simply an extension of the institutional VLE:

“The distinguishing feature of a PLE is ownership by the learner. For it to work successfully, the learner must be able manage learning across contexts, including the home, and to integrate institutional and personal sources of information.” (Sharples et al., 2010)

2.5.3 Challenges and opportunities

Mobile learning brings with it several challenges to technical support teams and logistical, as well as pedagogical, issues for teachers and curriculum support staff. The multiplicity and recurrent replacement of devices and applications which may be employed makes demands of technical support staff in terms of continually maintaining their professional development. Permitting user owned devices onto the network may aggravate this in terms of network security. In the course of our research interviewees commented on the complexity of the

technical infrastructure in today's schools in comparison to businesses (Phillips, 2010c). Clearly, to support access from different locations and at all times of the day and night represents an additional challenge with inherent risks. Equally, venues for location based learning will need to be assessed to ensure that the technology functions satisfactorily.

However, it is clear that the use of personally owned devices (phones, netbooks or laptops) has the potential to help schools manage the costly refresh of kit, and inexpensive applications may yet reduce the burden of licences at an institutional level. We have noted above the benefits of student familiarity with the technologies.

If learners are to be encouraged to create PLEs which allow them to take increased ownership and direction of their learning then this will make further demands of technical support models. Allied with this are concerns about data security and access control should we see a large-scale migration to cloud computing.

The Case Study of the Royal Veterinary College (Lackovic, 2010) highlighted other considerations such as the perceptions of parents and lecturers that mobile phones were tools for leisure activities and somehow inappropriate to academic study. Further to this, in a view espoused across all mainstream sectors of education, some teachers and lecturers were concerned about possible misuses of the phones – in particular the videoing of teachers and subsequent uploading of material to YouTube. The Project Director also noted the need for teachers, once they have identified mobile technologies as likely to enhance the teaching of their curriculum, to design appropriate learning activities rather than simply repeating their existing activities. Similarly, the learner-centred and learner-owned PLE requires new pedagogies from the teacher. Equally this may pave the way for innovative practice.

Some staff involved in the Yewlands Technology College mobile learning activities expressed a concern that the motivational impact of individual mobile technologies (in particular handheld gaming devices) may diminish relatively quickly. Whilst the use of these technologies was seen to be motivational in itself, there was a feeling that the freshness or novelty of the activities also contributed (Phillips, 2010b). However, the research suggests that generally the impact of mobile learning is *“...less contingent upon the novelty of the mobile devices deployed but owes more to the circumstances in which pupils are allowed to use them.”* (Sharples et al., 2010)

2.5.4 Summary

Cross-contextual learning on field trips or visits will continue to be contingent upon teachers having sufficient preparation time and, in some cases, the skills to develop materials gathered post-visit. Some activities may be reliant upon maintaining a connection across contexts (as opposed to, for example, a field trip where students may employ non-networked stand-alone devices) and there will be pressures to establish a robust yet flexible technical infrastructure.

“Context, then, is a central construct of mobile learning. It is continually created by people in interaction with other people, with their surroundings and with everyday tools. Traditional classroom learning is founded on an illusion of stability of context, by setting up a fixed location with common resources, a single teacher, and an agreed curriculum which allows a semblance of common ground to be maintained from day to day. But if these are removed, a fundamental challenge is how to form islands of temporarily stable context to enable meaning making from the flow of everyday activity.” (Kukulska-Hulme et al., 2009)

The use of mobile devices to support cross-contextual learning is now one of the better established features of the TEL landscape and the growing body of evidence provides sound justification. Mobile technologies offer the potential to support the development of PLEs and increased opportunities for collaborative learning and project-work. In parallel, the prospect of achieving cost-savings on desk-top machines and licences becomes increasingly enticing as pressure is focused much more sharply on budgets. However, perceptions of these devices as more suited to leisure activities and sensitivity to the risks to learners and infrastructure in the context of the school have yet to be resolved as conclusively as they perhaps have in Higher Education.

3. Opportunities and challenges of adopting and implementing technologies

The previous sections looked at how a particular technology could emerge as a credible mediation, or tool, to support certain learning interactions. Four examples were presented from our work that ranged in the extent to which they had become widely embedded in current practice. What was clear was the re-occurrence of certain mediating contextual

factors that seemed to enable or hinder wider adoption and establishment of these technologies. This section of the report identifies the key contextual themes that emerged across the Capital research that mediate the likely adoption and implementation of novel technologies to support learning. In order to help structure these themes, a basic framework is offered that draws upon the Generative Framework.

3.1 Mediating contextual factors

Table 2 lists the most salient mediating contextual factors around the adoption of technologies to emerge from this research. To a certain extent, these factors echo the different claims that were investigated in Year 2. This is perhaps to be expected, since the claims were derived from a large sample of assertions around the relationship between innovations and educational practice.

Table 2: Mediating factors

Home – School setting	The relationship between informal and formal settings
Learning Spaces	The design of the space in which technologies may be used
Curriculum Flexibility	The extent to which the curriculum can be adapted to accommodate different tools / ideas
Assessment Culture	The requirements to obtain and utilise specific assessment information
Leadership	The role of leadership at different levels, within and beyond individual institutions
Teacher skills / confidence	Individual teacher's own skills, attitudes and experiences toward technology
Reliability	The reliability of the technology when used
Appropriation of available tools	The extent to which tools used outside of education can be adapted

An important challenge is to provide a structure to communicate these factors in the most clear and comprehensive manner. Therefore, the next section presents a simple framework,

drawing upon the Capital Generative Framework, for systematising the *contexts* of learning. This framework is then compared to external work, where Luckin's (2009) framework of contexts is particularly relevant, and then used as a tool to describe the individual contextual factors listed in Table 2; factors that affect the likely adoption and implementation of novel technologies to support learning.

3.2 A framework for Contextual factors

3.2.1 The Generative Framework

The Generative Framework was proposed in the first year of the Capital work in order to look at the diverse nature of learning interactions and how these are re-mediated by new technologies and structured by contextual constraints. The first iteration of the Generative Framework is illustrated in Appendix B. The emphasis in this framework of learning acts was to provide a way to think of how technology, as a resource, could shape certain interactions.

These learning acts reflect different forms of interactions between the learner and their context: where this may be some form of external knowledge (e.g. browsing), in coordination with peers/teacher (e.g. collaboration, tutorial), or participation in some wider network (e.g. community). Some learning acts emphasise how interactions occur across environments (e.g. cross contextual). The Generative Framework then identifies various circumstances that may determine the shape of these interactions. These are categorised according to *Context* (e.g. setting, process, curriculum and subject), the *Technology* (Time, Place, Instrument) and *Agents* (e.g. Peers, teachers)

The types of mediating circumstances identified in the Generative Framework can be related to the three themes for the claims that were investigated in the second year of the Capital work: *Learning spaces and tools*, *Curriculum and assessment*, and *Workforce CPD*. The first theme, Learning spaces and tools, seems to capture both the Context (the physical environment such as the setting of the interaction) as well as the form of Technology. Curriculum and assessment can be compared to the Process, Curriculum and Subject headings within the theme Context of the Generative Framework and might be considered under the broader heading 'Learning Content'. The theme Workforce CPD focuses on particular Agents involved in learning interactions – in this case primarily the teachers.

It is possible to then look at the different contextual themes of the Generative Framework in light of the contextual factors identified in Table 2. Two factors: Home-school setting and

Learning spaces relate to the Environment. The Curriculum flexibility and Assessment culture themes relate to the Learning content. Leadership and Teacher skills fall under the theme Agents. Finally, Reliability and Appropriation of available tools refer to aspects of the technology. In summary, the contextual factors listed in Table 2 map quite well to the mediating circumstances categorised in the Generative Framework. One development to emerge is to distinguish the Generative Framework heading 'Context' into two themes: the Environment and Learning Content. Consequently, four contextual themes identified in this research are shown in Table 3.

Table 3: Contextual themes

Contextual theme	Description
Environment	Not only the different settings such as home and school but the nature of these, how spaces are designed, and how the infrastructure (e.g. servers) allows technologies to be integrated into a setting
Learning Content	The use of technology to support learning will be influenced by the knowledge and skills that are being taught, for example how curriculum content and structure is able to accommodate new technologies
Agents	The people influencing the use of technology, As listed in the Generative Framework, these might include Teachers, Leaders, Parents etc
Tools	In this context, we wish to focus on how aspects of the technology itself affect the ease with which it can be adopted

3.2.2 Luckin's Framework of Contexts

It is informative to compare the framework presented above with external work. The framework illustrated in Figure 1 was presented by Luckin at her inaugural lecture at the Institute of Education in 2009¹². The framework places the learner clearly at the centre, with three elements of context distinguished: *Knowledge*, *Resources*, and *Environment*. The framework highlights how these elements interact but importantly how they are 'filtered' or mediated by certain factors. For example, the ability to count is named as a form of knowledge, and the curriculum as a knowledge filter – a factor mediating the learner's

¹² <http://gallery.me.com/roaseluckin#100000>

access to this knowledge. The structure of different social relationships is an example of how certain (human) resources may be filtered.

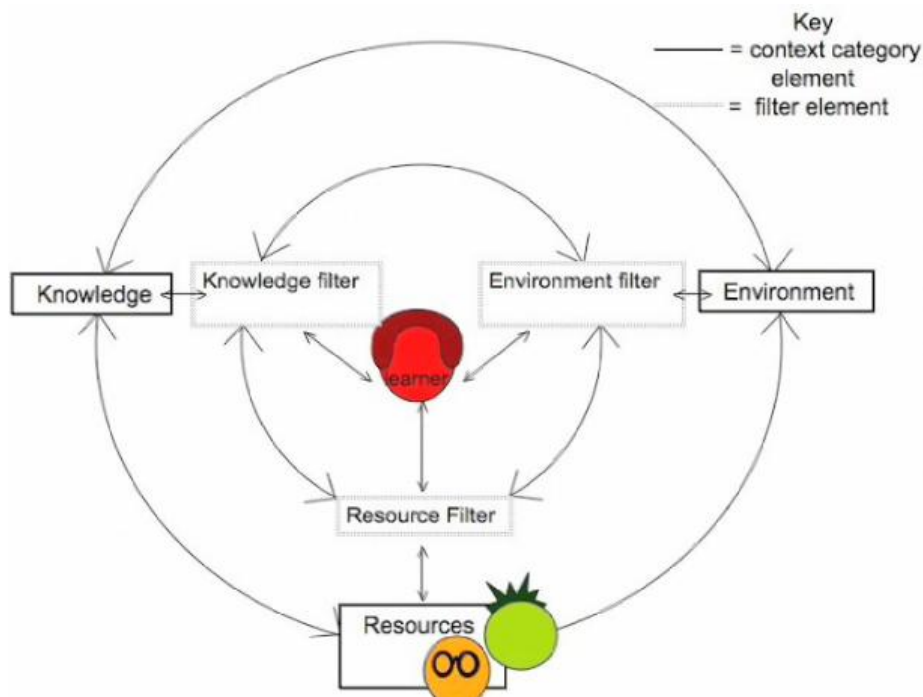


Figure 1: Luckin Framework of Learner context

In Luckin's framework, the language of 'context elements' and how these are 'filtered' can be compared to the emphasis in this section on how certain contextual factors shape learning interactions. In contrast to Luckin's framework, the generative framework focused more on a vocabulary for different types of learning interactions. The three key contextual elements of Luckin's framework can also be considered in relation to the four factors identified in this section. Knowledge may be related to Learning Content and the theme Environment arises in both frameworks. The factors Tools and Agents are grouped together under the heading Resources in Luckin's framework, arguably reflecting an emphasis on the interaction between these in the learning process. In contrast, without wishing to detract from the importance of this interaction, the framework presented here makes the distinction between human and physical resources in order to emphasise the role of agents, such as teachers or technicians, who can not only shape interactions but influence learners' access to technology. Leadership, for example, may influence whether a certain digital tool is adopted by the school. Therefore, whilst respecting the iterative nature of human and technology as a tool, it is more reflective of the Capital work to identify these separately in order to discuss themes related to each.

3.3 Context and the opportunities and challenges for adoption of technologies

In Section 2 we presented examples of how technology was able to mediate different learning interactions. In these examples, factors were identified that shaped contexts influencing the adoption and implementation of these technologies to support learning. It was clear in the Capital research that many contextual factors were recurrent and were relevant to a range of technologies and attempts to integrate them. This section has identified the most salient factors to emerge and provided a simple framework to discuss these. This framework is summarised in Table 4 and is intended to present a conceptual tool to reflect on individual institutions to help realise opportunities when adopting new technologies. The framework is used in the next section to discuss the different factors mediating the adoption of technologies in the Capital research.

Table 4: Contextual themes and mediation factors

Contextual theme	Key mediating factors identified
Environment	Home – School setting Learning Spaces
Learning Content	Curriculum Flexibility Assessment Culture
Agents	Leadership Teacher skills / confidence
Tools	Reliability Appropriation of available tools

3.3.1 Environment

The environments created by the interplay between the locations, the technologies, the cultures and the agents raise new issues and opportunities in TEL. New technologies are being employed to support learning within and across many different environments from the campus to museums and art galleries, to field trips, to workplaces and to homes. Indeed,

technologies have the potential to change the nature of learning in the classroom and, as reported in the Yewlands Technology College Case Study (Phillips, 2010c), can help the entire campus to be viewed as a space (or a series of spaces) for learning. In some cases technology may enhance traditional undertakings such as collecting samples and artefacts and taking notes on a school-trip for discussion on return to class. Increasingly, however, technologies can facilitate activities which would not previously have been possible – the use of location based devices or the use of a platform to share and access data from anywhere at anytime (such as the city- wide Bristol Eat-a-metre project,) or simply to capture images and audio.

Home - School setting

There has been a considerable drive towards increasing learners' access to their learning from home. In parallel there has also been a drive to increase parental access to their children's schooled learning. Although clearly aimed at maximising opportunities, this has been as the means to monitor pupils' progress rather than to instigate or enhance the conversation about learning (although the two are neither synonymous nor mutually exclusive).

Internet provision *in itself* does not lead to enhanced conversations about learning and there are significant disparities between schools with regards to making learning content available, accessible and current. For some learners, particularly those with disruptive domestic circumstances, the home is not necessarily the best place for out of school learning and alternative provision is necessary.

Previous research into (non-ICT facilitated) parental involvement in homework has also reported that disadvantaged parents can engage less in supporting their children than the better-off. However, the example of Shireland Gateway illustrate that where a coherent strategy is implemented the conversations between parent/carer and child and parent/carer and school can be enhanced (Stokes, 2010). For families without home access, schools might consider approaches where access is provided in community centres, mosques and supermarkets (e.g. Shireland). Teachers and practitioners generally seem to be strongly

persuaded by the research which suggested that ‘good Internet and computer facilities add one more GCSE grade to any pupil’ (Becta, 2009)¹³ .

There is significant enthusiasm for the acceptance, and integration, of learners’ own devices on and off-campus. In the HE sector this is now commonplace but schools remain generally far more cautious (Phillips, 2010b). The benefits in terms of ease of use and sustainability are widely accepted. However, there are clear technical implications and in some cases learners may be reluctant to use their own devices for learning activities (they may not wish to have video of themselves performing Shakespeare or a dance routine on another pupils phone, nor to use their own device for filming another pupil). Whether the user owned devices in question are PCs, notebooks, handhelds or phones, there will be questions of parity of experience.

Learning Spaces

The design of learning spaces can hinder or facilitate the pedagogical approach adopted and hence the way in which technology is used to support this. The move to change spaces partly reflects recognition of the need to move away from the traditional didactic model, however there appears to remain two typical set ups: rooms with no technology except a couple of PCs or ICT suites with rows of PCs. In the first type of room, there is little opportunity for the integration of technology. In the second, there is little opportunity for the integration of innovative pedagogy, such as collaboration and conversation. Both can inhibit innovative teaching and learning. A third familiar set-up, laptops on a trolley, can alleviate this stark contrast, but the time needed to book these out and set them up acts as a disincentive for many teachers.

The deployment of smaller devices and careful positioning of kit - so that the technology is unobtrusive but always available – can open up spaces for learning in new ways. Technologies can also help to create flexible and/or collaborative new spaces where new-builds are planned (e.g. Hallward). Consideration does need to be made though of practicalities of employing different devices – such as cables needed for power.

¹³ A number of independent studies have been carried out in the UK into the effects of technologies on attainment in selected subjects. See summary report by Becta, (2009) . http://partners.becta.org.uk/upload-dir/downloads/page_documents/research/impact_of_technology_on_outcomes_jul09.pdf

Whilst the remit of this research did not extend to investigating virtual learning spaces, it is clear that these have the potential to bring another dimension to the learning experience – either in tandem with the increasing range of physical learning spaces we have noted or with the likely growth of the ‘virtual campus’ model.

3.3.2 Learning Content

Curriculum flexibility

A significant challenge in adopting new technologies is to understand how their use maps onto curriculum. With a more rigid curriculum and timetabling for its delivery, this may be difficult as it can be impractical to introduce a novel tool simply to address particular domain specific content within a particular short period of time.

The growing interest in new curricula such as the RSAs Opening Minds (RSA, 2008), Futurelab’s Enquiring Minds (Futurelab, 2007) or the Australian New Basics (Queensland Government DET Education, 2004) has been inspired by the view that the traditional curriculum neither prepares students appropriately for the world of post-compulsory education nor takes account of their current non-school experiences. Our action research with schools using such curricula indicated great promise for how technologies can be integrated into more flexible ‘rich tasks’. A difficulty, however, was separating how the increased use of technology reflected the curriculum *per se* or the resultant change in pedagogy – the two are clearly interlinked.

Furthermore, whilst there remains a firm belief in the potential of technologies (perhaps the *necessity*) to support curricula developments there are also concerns about introducing another dynamic into an already ambitious attempt to transform pedagogy. This concern which was voiced by some in the deployment of the ‘learning platform’ and/or CPD issues may indicate the difficulties in translating innovation into whole-school change.

Assessment Culture

A clear theme to emerge from our investigations into the adoption of e-assessment was the dominant effect of summative assessments. Assessment scores can determine the future opportunities of learners and institutions, so shaping teaching practice. Consequently, if a tool does not directly benefit such performance measures, there is a danger that it is not seen as cost effective.

This notion was voiced during our investigation of tools to support higher order thinking as well as our focus on social learning tools. It was reported that a key barrier was encountered when these tools did not map to particular skills measured through assessment. Implicit to this argument is how assessment can hinder the adoption of new curricula that focus on a wider range of skills:

Since curriculum and assessment are inter-twined, then innovations in curriculum (such as 'rich task' learning through cross-disciplinary projects) need to be accompanied by new forms of assessment that can capture the richness of learning across times and settings then package it in a way that can offer both evidence of achievement and a source for reflection.” (Sharples et al., 2010, p. 10)

Designing technologies to meet assessment requirements is clearly a challenge therefore, although our work identified successful attempts to do so, such as the Bowland Maths Materials (Manches, 2010b). It is also important to emphasise here that whilst summative assessment pressures may represent a significant barrier, tools to support formative assessment offer great potential. Indeed, a commitment to formative assessment was perceived as a key enabler in the successful use of e-portfolios in the e-Scape project.

3.3.3 Agents

Leadership

During our research we heard from a number of sources (e.g. Innovation Forums, Case Studies and Claims Probes) that innovation had to be instigated from the bottom-up and supported from the top-down. However, it appears that definitions of this varied according to the role of the speaker. To the national policy-maker, bottom-up often meant from the 'institution' and top-down meant government and its agencies (including local authorities). To the practitioner bottom-up meant the classroom practitioner and top-down often meant the senior management team.

Our research and interviews provide strong evidence that leadership is a key influencing factor in the successful take-up and use of technologies within teaching and learning. We noted at Olney Primary school (Morgan, 2010a) the importance of leaders encouraging ownership through openness and trust which was manifested in a whole-school consultative approach to the new technology and allowing staff to take risks with the technology without fear of failure or ridicule. Another facet of the school's strategy was the introduction of new

contractual terms and conditions which make clear reference to daily use of, and familiarity with, technology. The leadership at this school provided support when staff faced practical challenges – such as the failure of technology to live up to expectations – but also established ‘mechanisms for support’, such as the provision of a dedicated ICT technician. Leadership commitment extends beyond CPD and technology implementation - one interviewee responsible for a new college rebuild commented that culture and leadership buy-in is also vital to the success of innovative learning spaces.

Leadership is therefore a key factor in the successful uptake of technologies, however, some interviewees pointed out that it was not necessary for leaders to do everything. Rather their strength was to “...empower others to move the learner journey forwards and to facilitate good practice through ensuring robust processes and procedures are in place” (Morgan et al., p. 11).

Leadership, also has a highly influential role in providing the appropriate training for teachers as well as engendering confidence, issues discussed in the following section.

Teacher skills, confidence and attitudes to innovation

One of the most persistent issues encountered during our research has been the ongoing challenge of professional development. Contributors to our *Innovation Forums* expressed concern about value-laden terminology and the need to be clearer that ‘what works’ is more important than ‘what’s new’. Indeed some felt that the terms such as ‘*innovator*’ may even alienate some staff (Jeans, 2010, p.2). Innovation can vary according to context and there is a need to acknowledge this rather than attempting to define a crude benchmark (Jeans, 2010, p.3).

Contributors at the Innovation Forums also noted the need to provide time for practitioners to investigate and ‘play with’ new technologies; to build the confidence needed to take risks and to be prepared to admit any lack of knowledge (Jeans, 2010,. 4-5). Indeed, some teachers still see technologies as making their professional lives more difficult (Phillips, 2010b) and specifically some perceive mobile learning as eroding their authority (Lackovic, 2010). Some staff involved in the Royal Veterinary College project did not see mobile phones as appropriate for learning believing that they were more suitable for texting and playing games – they also felt that parents shared this view. There were fears about students videoing lessons and posting these to YouTube (Lackovic, 2010).

Therefore, a significant challenge to adoption reflects the attitudes of teachers toward technologies. There is a perceived generational divide in the teaching profession although this is much more complex than often portrayed. Younger teachers *may* be less fearful of new technologies but that confidence does not *automatically* translate into classroom practice. We also found some suggestion that (older) teachers with teenage children were quite comfortable with new technologies since they were familiar with these from their home environment (Phillips, 2010b).

The above reflections should not imply negativity or pessimism. It is clear that there are numerous examples of 'innovation' across all sectors of education. Many teachers then are obviously managing their risks as they investigate new technologies. The value of one-to-one support (Jeans, 2010, Phillips, 2010b) is recognised and appreciated but there are fears about what happens when this person moves on, and they are invariably in demand. However, Yewlands used the role as a catalyst and seem to have handled the transition to 'innovation' becoming embedded (albeit within a small group) and sustainable. Informal peer support networks are seen by practitioners as valuable (Morgan et al., 2010, Claim 10) although the actual benefit is hard to substantiate. Consideration that CPD strategies are context specific (Balmer, 2010b) is also an important factor. It is crucial is for institutional leaders to create and maintain a supportive learning environment for teaching staff (Balmer, 2010b). Currently there is a role for Local Authorities or other bodies (including perhaps industry) to support where wider dissemination and adoption is actively sought (Balmer, 2010b). It is unclear how this will evolve in the more devolved landscape we may observe in the near term.

3.3.4 Tools

Reliability

Throughout our research, whether considering e-assessment, mobile learning, cross-contextual learning or CPD, a persistent theme is the reliability and predictability of the technology infrastructure. Somewhat surprisingly perhaps, some teachers and institutions also feel inhibited by existing pupil-to-device ratios, which remain far from one-to-one. Even today the quality of the technical infrastructure varies greatly from institution to institution. In some cases the pressure for more devices and a higher functioning infrastructure is a consequence of wide-scale innovation within the institution, whereas in others it may be due to insufficient or injudicious investment. Since we are unlikely to see again (in the near

future at least) investment in technology on the scale of recent years there is a pressing need to reconfigure technical support services, exploit new technological paradigms such as cloud computing and thin client solutions and/or encourage the integration of user-owned devices on the institutional network - on and off campus. However, each of these brings with it new considerations – key amongst these is the need for technical staff to have access to ongoing, high-quality professional development opportunities.

Two interviewees from different backgrounds and perspectives observed that the average Building Schools for the Future secondary school has a far more complex IT infrastructure than 90% of businesses in the UK (Phillips, 2010c). Whilst many schools are yet to benefit from BSF, and we note the disparities, many have also had significant investment in their technology infrastructure. This would seem to imply that there is the potential for some students to experience a technology rich learning environment which may well be the equal of, or better than, that they will experience in employment, Further or Higher Education. However, our interviewees reported that, by comparison with businesses, schools investment to support the infrastructure is typically low.

Just as the prospect of sudden increases in capital investment catalysed leaders to look at the Total Cost of Ownership (TCO) of their technologies and to establish appropriate technical support structures then the need to maximise reduced capital (perhaps through a move to user owned or hired devices, cloud computing etc.) and to exploit the existing investment should inspire a similar review. The potential to reconfigure support in order to improve the curriculum experience is illustrated in the Wickersley Case Study (Ugochukwu, 2010) which investigated the implementation of the Framework for IT Support (FITS). The application of FITS processes has the potential to free up resource to support curriculum innovation and can lead to improved relationships between staff and between staff and students.

Appropriation of available tools for education use

In our Claims-Probes, Action Research Projects and Case Studies we found evidence that schools were sometimes inhibited by their use of tools which were not designed specifically to meet their needs. Djanogly City Academy (Manches et al, 2010) was keen to exploit the social tools which students used outside of school. However, the tools they wished to use (such as Facebook) were deemed inappropriate within the school environment in terms of pupil safety and network security - and in the ability to track students' work. Attempts at

Djaongly to develop a bespoke platform have proved somewhat frustrating. The school also point out that they have invested significant resources – something which may well prove prohibitive for most institutions and indeed is increasingly unlikely in the current financial climate. Whilst investigating the potential of technology to support higher order thinking skills, an interviewee suggested that an important issue was the way in which some tools actually constrain higher order thinking by being too specific thus reducing the ability for the teacher to ‘take ownership’ and adapt them for a particular context (Patterson, 2010c). At Yewlands Technology College where the teachers had used gaming devices initially with ‘gaming’ in mind but had rapidly found these tools to have other applications we observed that:

“Once familiar with the devices in an educational setting the staff began to push the boundaries of use. Whilst this was a very positive outcome, it became clear that they were using the technology in ways for which it was not designed. As a consequence, even the manufacturers were behind the curve and sometimes unable to respond quickly to requests for development.” (Phillips, 2010b)

However, the fact that the ability of these tools to enhance the learning experience has been recognised by the teachers concerned (by no means all of whom are ‘evangelists’) and that they continue to find fruitful new ways in which these and other tools can support their pedagogies would seem to suggest that there is significant potential.

4. Summary Conclusions and Recommendations

The aim of this final section is to summarise some of the discussions of this report and present recommendations for future research and policy direction. Having summarised the report aims, attention will be given to how some of the emerging themes in this report map to the Harnessing Technology Strategy. Although these may not represent the current national strategy, they have influenced the development of this work. The second part of this final section will then summarise the key messages from this report, making reference to key findings, or recommendations, which can be found in the Year 2 final report and are listed in Appendix D.

4.1 Summary aims

The approach of this report has been to examine ways in which technology presents opportunities to mediate learning interactions and then identify key contextual themes that shape the realisation of these opportunities. To this end, four examples were presented from the Capital research that each illustrated the opportunities which novel digital tools bring to support learning. These examples, whilst justifying optimism regarding the potential of new technologies, also highlighted various contextual factors that constrain this potential. Consequently, a framework was presented for categorising these factors. This framework was used to discuss key contextual factors emerging from the Capital research that highlight the challenges and opportunities for adopting and implementing technology to support learning. One important message to arise from the Capital work concerns differences between institutions in the extent to which certain technologies have been adopted to support learning. These differences highlight how progress should not be thought of as simply 'more of the same', but depends upon strategies for structuring the most appropriate context for adopting technologies.

During the Capital project, strategies for realising the potential of novel technologies emerged from the research and were presented in a final document at the end of Year 2 (Sharples et al, 2010). These findings, or recommendations, were organised around the five outcomes of the Harnessing Technology Strategy. In light of governmental policy changes since this earlier report, it was decided to structure this final report according to emergent themes rather than these outcomes; however, considering their role in shaping the research, the next section summarises how the themes discussed in this report relate to the five outcomes of the Harnessing Technology Strategy.

4.2 Harnessing Technology Outcomes

Harnessing Technology was first published by the Government in 2005 (DfES, 2005) and revised in 2008 (Becta, 2008) and set out a system-wide strategy for technology in education and skills. In this strategy, 5 outcomes were presented:

- Improved Personalised learning Experiences,
- Confident system leadership and innovation,
- Technology confident effective providers,
- Engaged empowered learners,

- Enabling infrastructure and processes

Key objectives for these outcomes and how they relate to the Performance Framework of the Harnessing Technology Strategy are shown in Appendix C. How the Capital work discussed in this report maps to these outcomes is summarised below.

Improved Personalised learning Experiences

The Capital work has taken a learning focused approach. This is illustrated through the work to identify different learner interactions and how these are mediated by technology. Investigations have also focused on the different forms of curriculum that may improve learner experiences as well as how assessment might be transformed to benefit learners. Work has also focused on other forms of technology that might improve experiences such as gaming for motivation or tools to engage higher order thinking.

Confident system leadership and innovation

A theme to emerge in our work is the important role of leadership in facilitating the adoption of technologies. This was reflected in the investigation of Leadership as a claim in Year 2 and was also a key theme to emerge from the innovation workshops, where leaders' attitudes to risk and their support of teaching staff emerged as central factors.

Technology confident effective providers

Another key theme to emerge in this work is the importance of teachers' attitude and confidence with technology. Considering the importance of teachers' skills, the role of local authority CPD and peer training were investigated as claims in year 2. These highlighted the beneficial source of support that informal networks can provide. The research also examined the types of technology themselves, highlighting the challenge for providers to adapt informal tools into their context. Work was also carried out into how internet links between home and schools could be developed to support learning, although findings showed how such bridging needs to take account of issues such as differences between home contexts.

Engaged empowered learners

A theme running through the Capital work is how new forms of technology make learning more accessible and can support inclusion. A significant area of focus has been the use of the internet and mobile technologies to support learning in out of school contexts, where

findings suggest great potential. Another overarching theme has been e-safety where a significant challenge for schools is ensuring a safe environment for learners whilst not being averse to experimenting with novel tools for learning.

Enabling infrastructure and processes

A key factor affecting teacher and leaders' attitude to adopting technologies was the reliability of the technologies being adopted. Taking this into account, strategies for investing in new technologies need to be coordinated with strategies for maintaining the reliability of the infrastructure. The action research reports in the Capital work were able to trace the challenges of such strategies over time, highlighting the need to consider the costs of maintaining equipment from the initial planning. The claim work focused on the role of managed services and emphasised the value of greater involvement of ICT technical staff in school practice.

4.3 Recommendations

As emphasised throughout this report, the aim of Capital work has not been to predict the trajectory of new technologies or even make suggestions for which technologies merit greater investment (e.g. Johnson, Levine & Smith, 2009). Instead, the work has focused on identifying how to maximise the potential for technologies. Doing so requires a good understanding of the contextual variables mediating this potential and strategies for addressing these. On these matters, we present recommendations. Given the scope of Capital work, summarising the findings in this section is challenging and the reader is firstly directed toward work published during the last two years. This work, along with previous unpublished materials is available through the University¹⁴. A significant document is the Year 2 summary report where key findings were presented and mapped to the Harnessing Strategy Outcomes (Sharples et al, 2010). These twenty two findings, or recommendations, are numbered and listed in Appendix D. The purpose of this final section is to summarise these recommendations using the framework developed within this report. Accordingly, the findings are summarised under the following four headings:

- Environment,
- Learning content

¹⁴ www.lsri.nottingham.ac.uk/capital

- Agents
- Tools

4.3.1 Environment

Capital research has emphasised the opportunities for learning across settings. One clear message is that all sectors should explore new ways to lower boundaries between places of study, types of learner, abilities, and mode of learning. Schools can help achieve this through the efficient use of resources, by including open learning content in their teaching and by connecting classes through videoconferencing for instance.

Ways to support informal learning in home settings has been an important theme and further research should examine the wider benefits of home access to internet resources, such as enabling enquiry-led learning and project work in the home. Schools should also have guidance on how best to accommodate learner-owned devices, such as laptops and mobile phones, so that these are managed as devices for productive learning between home and school. However, there needs to be greater recognition that home can be a setting for tensions, with the family computer as the focus of conflict. Schools need support in making alternative provision for young people who are not able, or not willing, to learn online at home.

Children clearly bring to school many skills they have acquired in their home settings and schools should build upon this technical, media and collaboration experience and enthusiasm. The focus should be less on teaching about the technology and more on how to learn with new technology.

As well as considering the bridge between home and school, it is important to consider the school environment itself where Capital work has emphasised the impact of different spaces. Therefore, physical learning spaces (classrooms, campuses) should be designed from the outset for flexible technology-equipped learning and with prior consideration of the various pedagogies that affords.

4.3.2 Learning Content

The Capital work has looked at the impact of the curriculum on pedagogy and the use of technology. This has involved research on alternative forms of new curricula being provided,

such as 'New Basics', and tentative evidence that more flexible curricula structures provide more opportunities to accommodate technology. One key challenge is to change the culture of assessment where the requirements for summative assessment can unhelpfully drive practice. In this situation, there is a significant opportunity to develop assessment for learning, through diagnostic testing with rapid feedback, rich media assignments and feedback, and e-portfolios for self-reflection. There is also a need to support and assess learning over longer periods, through e-portfolios and activity logs.

New tools can support the assessment of new forms of curricula and new software is therefore needed to help in the assessment of 'rich tasks' that mix text, images, sound and video. Clearly, it is not just the technology, but how it is adapted and delivered within practice. One finding from the research considers how higher-order thinking can be developed through more project work both inside and beyond the classroom. More attention should be given to how technology can support this, with students working together to construct shared understandings and representations of complex problems.

4.3.3 Agents

One theme to emerge in the research is the perceived risk of introducing new technologies. Therefore schools, particularly school leaders, need encouragement to adopt radical solutions. An example of such a solution might be encouraging the use of learner-owned and personally managed devices to improve personalised learning experiences while reducing the cost of providing large numbers of desktop computers in schools.

Our research indicates that strong leadership from the top can facilitate change by creating a culture of openness and trust. Head teachers, College Principals and others with responsibility for CPD strategies should give space for teachers to experiment, while managing the risks. Giving teachers this space should help develop confidence, which needs to be further developed by building teacher skills. Teacher professional development should identify the skills and needs of each individual. Support may then be offered through a mix of formal training and personal learning communities (PLCs), with progress evaluated through self-reflection, peer critique and a portfolio of recorded achievements. Our investigation also found strong support for peer-to-peer learning as an expanding force in

professional development. This should form part of a blended approach in which more informal, socially networked learning is merged with formal training.

It is also important to consider the role of other agents within the educational setting. Technical staff, for example, have crucial roles not only in supporting change, but also in demonstrating new possibilities and providing critiques of narrow assumptions about technology.

4.3.3 Tools

The Capital work has looked at how different technologies that are currently available support learning interactions. E-assessment for example has been discussed as a means to transform learners' experience. Another technology that offers exciting potential is mobile technologies where we have found good evidence that they can enhance learning on visits and field trips, by connecting teacher-managed activities in the classroom with student-led explorations in museums. This can provide resources for further exploration and sharing back at school but schools do need guidance on how to design and manage technology-enhanced field trips and visits.

The Capital work has also examined the potential of other developments, some of which have not been described in this current report. Cloud computing, for example, may bring efficiencies in all sectors, based on a combination of specialist education services, industry provision, open source applications, and open content – but only if concerns over data security and access control can be addressed. Capital has also investigated and found evidence for the successful student personal learning communities in large IT companies and in the 'study groups' of the Open University. This model of extended peer-supported learning also matches the 'rich task' pedagogy, opening the possibility of supporting both workforce development and student learning through a similar set of technologies and processes.

A key theme to emerge with respect to tools is the opportunity for schools to adapt some of the growing number of resources which become available outside of the educational sector. Indeed, all sectors need to find effective ways to blend institutional services (such as VLEs) with products, often commercial, such as Web 2.0 and media sharing sites. Clearly, safety is a key issue and there needs to be a national debate on how institutions can support learners

to engage in creative social learning through Web 2.0 technologies, helping them to develop appropriate strategies while protecting them from undue harm.

4.4 Final Summary

The findings described above present some key recommendations from the Capital research. The most significant contribution, however, is intended to be the language and framework developed in this report that provides a tool to help reflect and act upon practice. This report has provided a structure to identify the full diversity of interactions that make up 'learning' and hence an aid to consider how different forms of technology might be adopted to support such interactions. The potential of any technology, however, will depend on a range of contextual variables, and this report has attempted to map the most significant of these. Understanding how these factors play their role in individual institutions is key to maximising the benefits of adopting new technologies.

Capital work emphasises the old adage that it is 'not what you've got, but how you use it'. There is now greater recognition of the need to develop a more systemic approach, especially at the level of individual institutions, towards the combined progression of technology and pedagogy. The challenge is to promote and learn from these systems of success, in a period of diminishing public resources. Efficiencies will not come directly from the introduction of technology into education, since any new technology requires additional effort and resources for adoption and support, but through imaginative and sustained combinations of technology, teaching, learning and assessment.

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6. Appendices

Appendix A: Claims for the benefits of technologies for learning

(Sharples et al, 2010)

Learning Spaces and Tools	Claim 1	Learning can be connected across formal and informal settings through mobile technology.
	Claim 2	School development of innovative, relevant, engaging and creative curricula can be enhanced by responsive and flexible technical support services
	Claim 3	Conversations between children and parents/carers about learning can be enhanced through internet connections between home and school.
	Claim 4	Radical innovative approaches to learning and teaching can be supported by redesign of learning spaces which incorporate new technologies to help learners develop the skills, knowledge and expertise necessary in an ever-changing world.
Curriculum and Assessment	Claim 5	Learners in all sectors can benefit from new forms of technology-enabled assessment
	Claim 6	Students can be motivated to develop the skills they need for the 21st century through new curricula that integrate new-media technology and social learning.
	Claim 7	Teachers can promote higher order thinking by project work at all levels of educations through use of ICT tools for interactive visualisation and simulation
Workforce Training and Development	Claim 8	Capital Funding has acted as a catalyst for authority wide CPD TEL strategies which have led to an increase in the quality and accessibility of teaching staff's CPD in TEL.
	Claim 9	Leadership issues are the dominant factor in innovative technologies (Web2.0, IWBs, VLEs) being used to transform teaching and learning
	Claim 10	Practitioners develop more innovative and transformational uses of technology through informal and peer learning than from formal training.

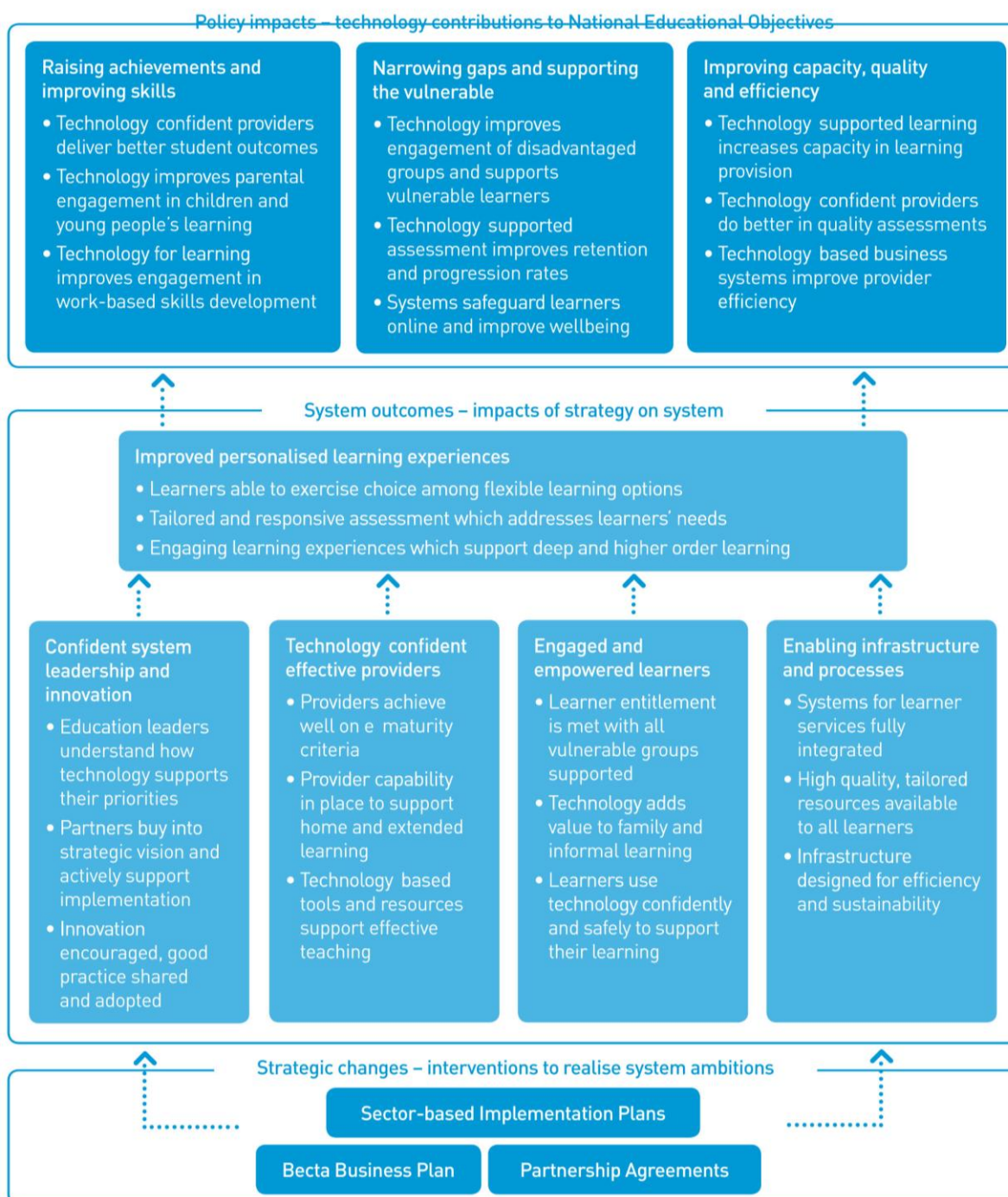
Appendix B: The Generative framework

(Sharples et al, 2009a)

Learning Practice	Mediating Circumstances		
Interaction	Context	Technology	Agents
Exposition	Setting	Time	Peers
Reflective	Workplace	Synchronous	Teachers
Performative	Classroom	Asynchronous	Mentors
Networked	Home....	Place	Technicians
Community	Process	Contained	Supporters
Collaborative	Scripted	Co-located	Parents
Tutorial	Open	Distributed	Siblings
Assessing	Curriculum	Virtual	Carers...
Browsing	21 st century	Instrument	
Cross-contextual	Nuffield	Representation	
Cross-conceptual	Basics...	Augmentation	
Case-based	Subject	Simulation	
Problem-solving	Maths	Construction site	
Inquiry-driven	ICT...	Recording	
Ludic		Computation	
Construction		Communication	

Appendix C – Harnessing Technology Outcomes (Becta, 2008, p. 47)

Performance Framework for the Harnessing Technology Strategy



Appendix D: Capital Recommendations for the adoption and /or implementation of technologies to support learning

Recommendation Number	Finding reported in end of Year 2 report
1	We have found good evidence that <i>mobile technologies</i> can enhance learning on visits and field trips, by connecting teacher-managed activities in the classroom with student-led explorations in museums, which provide resources for further exploration and sharing back at school. Schools need guidance on how to design and manage technology-enhanced field trips and visits (Claim 1).
2	Schools should have guidance on how to accommodate <i>learner-owned devices</i> , such as laptops and mobile phones, so that these are managed as devices for productive learning between home and school (Claim 1).
3	All sectors should explore new ways to <i>lower boundaries</i> between places of study, types of learner, abilities, and mode of learning, and enable efficient use of resources, by including open learning content in their teaching and by connecting classes through videoconferencing. (Claim 1).
4	Higher-order thinking can be developed through more project work inside and beyond the classroom., More attention should be given to how technology can support this, with students working together to construct shared understandings and representations of complex problems (Claims 1, 3 and 7).
5	Technical staff have important roles not only in supporting change, but also in demonstrating new possibilities and providing critique of narrow assumptions about technology (Claim 2).
6	Schools should build upon the technical, media and collaboration experience and enthusiasm that children bring. The focus should be less on teaching <i>about</i> the technology and more on how to learn <i>with</i> new technology (Claim 2).
7	In all sectors <i>cloud computing</i> may bring efficiencies, based on a combination of specialist education services, industry provision, open source applications, and open content – but only if concerns over data security and access control can be addressed. (Claim 2)

8	The <i>wider benefits of home access</i> to internet resources should be examined, such as enabling enquiry-led learning and project work in the home (Claim 3).
9	There needs to be greater recognition that <i>home can be a setting for tensions</i> , with the family computer as the focus of conflict. Schools need support in making alternative provision for young people who are not able, or not willing, to learn online at home (Claim 3).
10	Schools need encouragement to adopt radical solutions, such as supporting <i>learner-owned and personally managed devices</i> to improve personalised learning experiences while reducing the cost of providing large numbers of desktop computers in schools (Claim 3).
11	All sectors need to find effective ways to blend institutional services (such as VLEs) with products, often commercial, such as Web 2.0 and media sharing sites (Claim 4).
12	Physical learning spaces (classrooms, campuses) should be designed from the outset for flexible technology-equipped learning and with prior consideration of the various pedagogies that affords (Claim 4).
13	There is a significant opportunity to develop <i>assessment for learning</i> , through diagnostic testing with rapid feedback, rich media assignments and feedback, and e-portfolios for self-reflection (Claim 5).
14	New software is needed to help in <i>assessment of 'rich tasks'</i> that mix text, images, sound and video (Claim 5).
15	There is a need to support and assess <i>learning over long periods</i> , through e-portfolios and activity logs (Claim 5).
16	There needs to be a national debate on how schools can support children to engage in creative <i>social learning through Web 2.0 technologies</i> , helping them to develop appropriate strategies while protecting them from undue harm (Claim 6).
17	Evidence for the successful student <i>personal learning communities</i> can be found in large IT companies and in the 'study groups' of the Open University (Claim 6). This model of extended peer-supported learning also matches the 'rich task' pedagogy, opening the possibility of supporting both workforce development and student learning through a similar set of technologies and processes.

18	Teacher professional development should identify the skills and needs of each individual. Support may then be offered through a mix of formal training and <i>personal learning communities</i> (PLCs), with progress evaluated through self-reflection, peer critique and a portfolio of recorded achievements (Claim 8).
19	Our research indicates that strong leadership from the top can facilitate change by creating a culture of openness and trust. Head teachers should give <i>space for teachers to experiment</i> , while managing the risks (Claim 10).
20	Our investigation found strong support for <i>peer-to-peer learning</i> as an expanding force in professional development. This should form part of a blended approach in which more informal, socially networked learning is merged with formal training (Claim 10).
21	Efficiencies will not come directly from the introduction of technology into education, since any new technology requires additional effort and resources for adoption and support, but through imaginative and sustained combinations of technology, teaching, learning and assessment.
22	There is now greater recognition of the need to develop a more systemic approach, especially at the level of individual institutions, towards the combined progression of technology and pedagogy. The challenge is to promote and learn from these systems of success, in a period of diminishing public resources.